MISB MOTION IMAGERY STANDARDS BOARD	MISB ST 1101
STANDARD	
STANAG 4586 Control of UAS Motion Imagery Payloads	**23 October 2014**

1 Scope

This Standard (ST) provides guidance for the control of Motion Imagery (MI) payloads on a platform, such as an Unmanned Aerial System (UAS). Emphasis is given to Large Volume Motion Imagery (LVMI) payloads, but this guidance applies as well to Ultra High Definition (UHD), High Definition (HD), and Enhanced Definition (ED) payloads. Specifically, this document references a set of control messages for directing a Motion Imagery sensor, extracting a region-of-interest view, and selecting the format for delivery to a ground receiver.

The control messages referenced here are published in NATO STANAG 4586 [1] and Army UAS Program Office's (PO) Private Messages Interface Control Document (PM ICD) [2]. STANAG 4586 is the NATO specification for control of UAS platforms and their payloads, which may include MI sensors, SAR sensors, communications equipment, laser designators, weapons, etc. The PM ICD is a controlled set of extension messages to STANAG 4586, which is maintained and managed by the U.S. Army. The PM ICD evolves more quickly than STANAG 4586 with PM ICD messages eventually propagating to future versions of STANAG 4586. This document does not address platform control, communications control, etc.

The messages referenced in this Standard have been accepted into the PM ICD, where they are normative. Appendix A lists these messages and their fields for convenience and as informative only. Appendix B lists messages under consideration by PM ICD, but not yet adopted. Appendix C provides examples of a virtual sensor.

2 References

2.1 Normative References

The following references and the references contained therein are normative.

[1] NATO STANAG 4586 Edition 2, Amendment 2, Nov 2007
[2] Army IOP PM ICD Version 3.0.2, Feb 2014
[3] MISB MISP 2015.1, Motion Imagery Standards Profile, Oct 2014
[4] MISB ST 0902.3, Motion Imagery Sensor Minimum Metadata Set, Feb 2014
[5] NATO STANAG 4609, Edition 3, Dec 2009

2.2 Informative References

[6] MISB RP 1011.1, LVSD Motion Imagery Streaming, Feb 2014
[7] MISP RP 0904.1, H.264 Bandwidth/Quality/Latency Tradeoffs, Feb 2014

3 Acronyms

bps	bits per second
CUCS	Core UAV Control System – the 4586 client
DLI	Data Link Interface
ED	Enhanced Definition
ES	Elementary Stream
HD	High Definition
HP	High Profile
FOV	Field of View
FPS	Frames per Second
GOP	Group of Pictures
IP	Internet Protocol
LVMI	Large Volume Motion Imagery.
MI	Motion Imagery
ML	Main Level
MP	Main Profile
RTP	Real Time Transport
RVT	Remote Video Terminal
TS	MPEG-2 Transport Stream
UAS	Unmanned Aerial System
UDP	User Datagram Protocol
VSM	Vehicle Specific Module

4 Definitions

LVMI	Applies to systems which collect large imagery – on the order of 100 to 1000 Megapixels/image. LVMI systems typically acquire imagery greater than one frame-per-second and may operate for hours at a time. These systems are also known as WALF (Wide Area Large Format), WAAS (Wide Area Aerial Surveillance), WAMI (Wide Area Motion Imagery), WAPS (Wide Area Persistent Surveillance), etc.
MISP compliant Motion Imagery Data	Data types of Motion Imagery, Metadata and Audio wherein all data types and container encapsulations comply with MISP Requirements and Standards.

5 Revision History

Revision	Date	Summary of Changes
Initial	10/23/2014	First non-draft version. Synchronized with USA IOP 3.0.2

6 Introduction

This document specifies requirements for the control of a Motion Imagery payload, specifically for LVMI Motion Imagery region-of-interest processes. However, all messages and functionality are appropriate for any MI sensor that supports STANAG 4586 and PM ICD messages. As used here, a "**window**" is a region-of-interest extracted from a larger Motion Imagery field-of-view; typically, a window is formatted as Enhanced or High Definition Motion Imagery for delivery to a receiver, although other formats are supported. Also known as a soda-straw view or chip-out, a window is compliant with MISP standards and requirements. Other LVMI aspects, such as full field-of-view file formats, archiving of LVMI data, etc. are not discussed here.

NATO STANAG 4586 defines messages for command and control between a UAS and Ground Station or Remote Video Terminal (RVT). Each message has a fixed-field format. A subset of these messages is for controlling a Motion Imagery sensor/payload. As an extension to 4586, additional messages have been added to the Army PM ICD to accommodate the special needs of LVMI payloads, although these can be used for other Motion Imagery payloads as well. This document describes the purpose and functionality of these messages.

STANAG 4586 does not, in general, define error messages. Rather, many messages work as pairs with a request status and response. Typically, a request is made to change a parameter or initiate an action. The response indicates updated post-request status. If a platform or payload receives a request outside of its capability, rather than return an error a best effort approximation of what was requested is made, and the response/status message indicates the action taken. For example, if a Motion Imagery sensor is capable of producing a maximum of 30 Frames per Second (FPS) and is issued a request for 60 FPS, the status response will simply indicate 30 FPS, since that is the nearest supported capability.

Motion Imagery payload products are expected to be MISP compliant. 4586 messages do, however, permit the request of Motion Imagery in non-compliant formats, such as Motion-JPEG.

Requirement(s)	
ST 1101-01	In the default mode, a Motion Imagery payload shall produce MISP-compliant Motion Imagery Data [3].

Notes on messages:

Messages are defined in STANAG 4609[1] and PM ICD [2], which are the normative references for all messages discussed in this document. Messages added to PM ICD that support the functionally of this Standard are listed in Appendix A of this document; these are informative only and are only provided for convenient reference. Any use of these messages should refer to [1][2] to assure accuracy. Finally, only those messages introduced into the PM ICD that support the functionality described in this document are indicated in the following message diagrams.

Other LVMI aspects, such as full field-of-view file formats, archiving of LVMI data, etc. are not discussed in this document.

7 Sensor Addressing and Discovery

Each STANAG 4586 or PM ICD message directed to/from a payload, as opposed to the platform itself, contains a field called "**Station Number**" (used interchangeably in 4586). This designates a specific physical payload, from among those possible, that a message affects.

Requirement(s)	
ST 1101-02	All Motion Imagery payload messages shall contain the STANAG 4586 [1] field "**Station Number**".

A physical LVMI sensor produces high pixel-density Motion Imagery generally undeliverable using conventional transmission methods. Within the LVMI field-of-view, extracted windows of Motion Imagery formatted to meet a constrained channel can be delivered as separate MI streams. Each window from a physical sensor is a "**virtual sensor**", or in STANAG 4586 terminology a "**Virtual Station**". Numerous Virtual Stations may be associated with a single "**Physical Station**".

STANAG 4586 defines a Station Number using a 32-bit bitmap, where each bit corresponds to a "station" or payload. This permits up to 32 payloads – physical plus virtual. Although an LVMI system may support more than 32 "sensors", at this time the total number of physical plus virtual stations or payloads is capped at 32. Future editions of STANAG 4586 may address this restriction.

7.1 Summary of Existing Station Discovery Mechanism

A Station Number of 0 (zero) is a reserved special broadcast station number, and is used when first establishing contact for discovery of the available physical stations/payloads as follows:

- A CUCS (in 4586 nomenclature, the client is called a CUCS – Core UAV Control System) sends a 4586 Message #1 *CUCS Authorization Request* with the Station Number set to the broadcast station number.
- The platform responds by sending Message #21 *VSM Authorization Response* for every physical station the CUCS can potentially control. A VSM is a vehicle specific module (see STANAG 4586 for details). A CUCS may monitor all *VSM Authorization Response* messages on the network, not only the messages directed to that CUCS. By monitoring all messages, a CUCS will know what platforms/payloads are available for control, and what platforms/payloads are currently controlled by other CUCS.
- The platform also sends Message #300 *Payload Configuration* per Physical Station containing various station properties. For EO/IR payloads, the platform sends Message #301 *EO/IR Configuration State* and Message #302 *EO/IR/Laser Operating State* for all EO/IR stations, including virtual stations, in use.

7.2 Discovery of Virtual Stations

Once the physical sensors are discovered as described in Section 7.1, virtual sensors corresponding to windows from the physical sensor may be requested. Two new messages support requesting a virtual sensor: Message #20005 *Virtual Sensor Request Command* and Message #20102 *Virtual Sensor Status*.

7.2.1 Message #20005: Virtual Sensor Request Command

Message #20005 *Virtual Sensor Request Command* is sent by a CUCS to the platform, specifying a physical sensor station, to request an associated virtual sensor (see Figure 1). The platform may host multiple physical sensors each having virtual sensor capability. Message #20005 specifies the physical sensor that is the source for the requested virtual sensor. The CUCS need not, but may, have control of the physical sensor being queried.

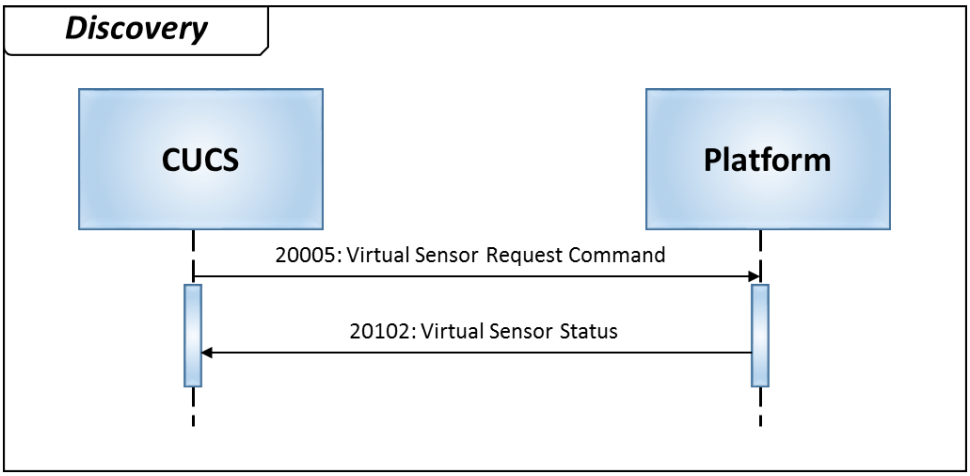

Figure 1: Virtual Sensor Request Command/Status

7.2.2 Message #20102: Virtual Sensor Status

In response to a *Virtual Sensor Request Command*, the platform responds with a Message #20102 *Virtual Sensor Status*, which returns the **Virtual Station Number** associated with the virtual sensor, and the **Physical Station Number** of its parent physical sensor. Note that a physical sensor could have multiple virtual sensors; the platform, if possible, returns one that is available for use. If no virtual sensors are available, one currently in use may be sent.

Once the CUCS receives an available Virtual Station Number, it treats it like any other Station Number and sends Message #1 *CUCS Authorization Request* to gain control over the virtual sensor. In the event the *Virtual Sensor Status* returns an "in use virtual sensor", a CUCS with override capability can take control of that virtual station. Note: the process of override capability is beyond the scope of this document (see [1] and [2] for this information.)

In response to the *CUCS Authorization Request*, the platform sends Message #21 *Mode Preference Command*, Message #300 *Payload Configuration*, Message #301 *EO/IR Configuration State*, and Message #302 *EO/IR/Laser Operating State* providing the type/modality of the virtual sensor.

Requirement(s)	
ST 1101-03	A platform that conforms to MISB ST 1101 shall implement Message #20005 *Virtual Sensor Request Command* and Message #20102 *Virtual Sensor Status* in accordance with PM ICD [2].

8 Playback from Storage

Playback (moving temporally through Motion Imagery) from an archived data set is an important but optional capability, since not every platform will provide storage for an archive. Recording full field-of-view LVMI requires an on-platform archive, because platform-to-ground communications are likely to be insufficient for delivery. Implementation options for LVMI retrieval include: 1) provide the capability to transmit real-time live-only windowed Motion Imagery with no local recording ability (least capable); 2) local buffering or recording of the most recent M minutes, continually dropping content older than M minutes; and 3) recording all content locally, while supporting delivery of windowed Motion Imagery (most current LVMI systems).

The benefits of archive access are compelling. An archive affords "instant replay" of a past event that may need further review. Data is of higher quality, because it may not be compressed. Data is persistent and available for future exploitation. LVMI systems enhance these advantages by allowing the user to re-center on the replayed event if it was originally partially off-screen, to zoom-in for enhanced detail, or to zoom-out for additional context.

8.1 Message #20007: Payload Playback Configuration Command

Message #20007 *Payload Playback Configuration Command* supports playback from an on-platform archive (see Figure 2).

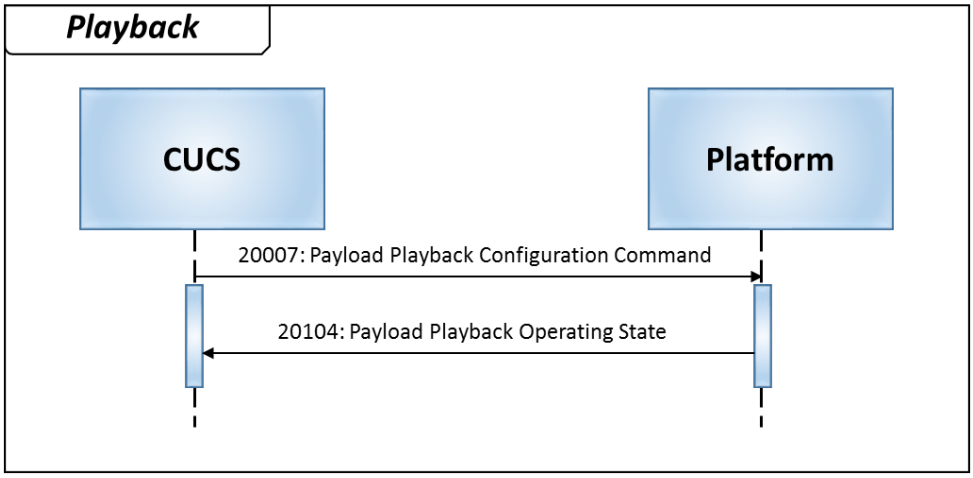

Figure 2: Payload Playback Configuration Command/Operating State

Message #20007 is intended to be analogous to, and a companion of, Message #200 *Payload Steering Command* – but applied to the temporal dimension. When a platform supports storage, it provides one recording i.e. "the Recording", which is everything collected by a station. There is,

therefore, no need for archive search or selecting from a choice of recordings. Message #20007, similar to Message #200, is per-station as indicated by the Station Number. Multiple CUCS may simultaneously adjust the Playback Mode for their own virtual sensor without impacting CUCS using other virtual sensors.

Requirement(s)	
ST 1101-04	In support of a virtual sensor, Message #200 *Payload Steering Command* and Message #201 *EO/IR/Laser Payload Command* shall function in accordance with STANAG 4586 [1] when in either the live or archive mode.
ST 1101-05	A Motion Imagery Payload shall support the closest requested Playback Rate.

8.2 Message #20104: Payload Playback Operating State

Message #20104 *Payload Playback Operating State* reports the operating state of the playback to the CUCS. It is sent in response to the *Payload Playback Configuration Command* (Message #20007) and reflects actual state. If *Payload Playback Configuration Command* specifies out-of-capability settings, *Payload Playback Operating State* indicates the best-effort settings in effect. Not all systems support all playback options, but are to operate on a best-effort basis. Clearly, systems without an on-platform archive will not support archive playback. Further limitations are imposed by the format chosen for the archive and the transcoding capabilities available, for instance JPEG-2000 to H.264/AVC.

Requirement(s)	
ST 1101-06	A platform that conforms to MISB ST 1101 and implements Motion Imagery playback capability shall support Message #20007 *Payload Playback Configuration Command* and Message #20104 *Payload Playback Operating State*.

9 Sensor Pointing / Steering

As directing a sensor to point in a particular direction is one of the basic intents of STANAG 4586, this capability is well addressed by Messages #200 and #201 in 4586. Message #201 *EO/IR/Laser Payload Command*, specifies setup parameters, while Message #200 *Payload Steering Command* directs the actual pointing. The meaning of Message #200 is strongly influenced by the current state of the system, as set with Message #201, particularly the **EO/IR Pointing Mode** field of Message #201. For example, if **EO/IR Pointing Mode** = 4 (Lat-Long Slaved), then the latitude and longitude fields of Message #200 are populated by the CUCS, and the sensor responds by pointing toward the specified coordinate. Similarly, if **EO/IR Pointing Mode** = 2 (Slewing Rate Relative to AV), then the horizontal and vertical slew rate fields of Message #200 are populated by the CUCS.

Requirement(s)	
ST 1101-07	If Message #201 *EO/IR/Laser Payload Command* sets EO/IR Pointing Mode = 5 (Target Slaved (track)), then Message #200 *Payload Steering Command* shall be only used to adjust zoom level (Field 7 Set Zoom) and focus (Field 16 Set Focus); the

	latitude, longitude, and slew rate fields will be ignored by the sensor while in target tracking mode.
ST 1101-08	A LVMI system shall support Message #200 and Message #201 (i.e. pan/tilt/zoom) for a non-LVMI aware CUCS.

Sensor pointing using Messages #200 and #201 is intended to function whether a sensor is physical or virtual. It is likewise intended to work whether a sensor is operating live, or is in archive playback mode.

10 Motion Imagery Format and Encoder Properties

Message #20000 Encoder Capabilities Request, Message #20100 Encoder Capabilities Status, Message #20001 Encoder Parameter Control, Message #20103 Encoder Parameter Status, Message #20006 Encoder Configuration Request and Message # 20002 I-Frame Request (see Figure 3) all support discovery and selection of the Motion Imagery format, encoding parameters and transport. It is important the CUCS and the platform agree on which settings to use within the capabilities available. This is particularly important in supporting backward compatibility.

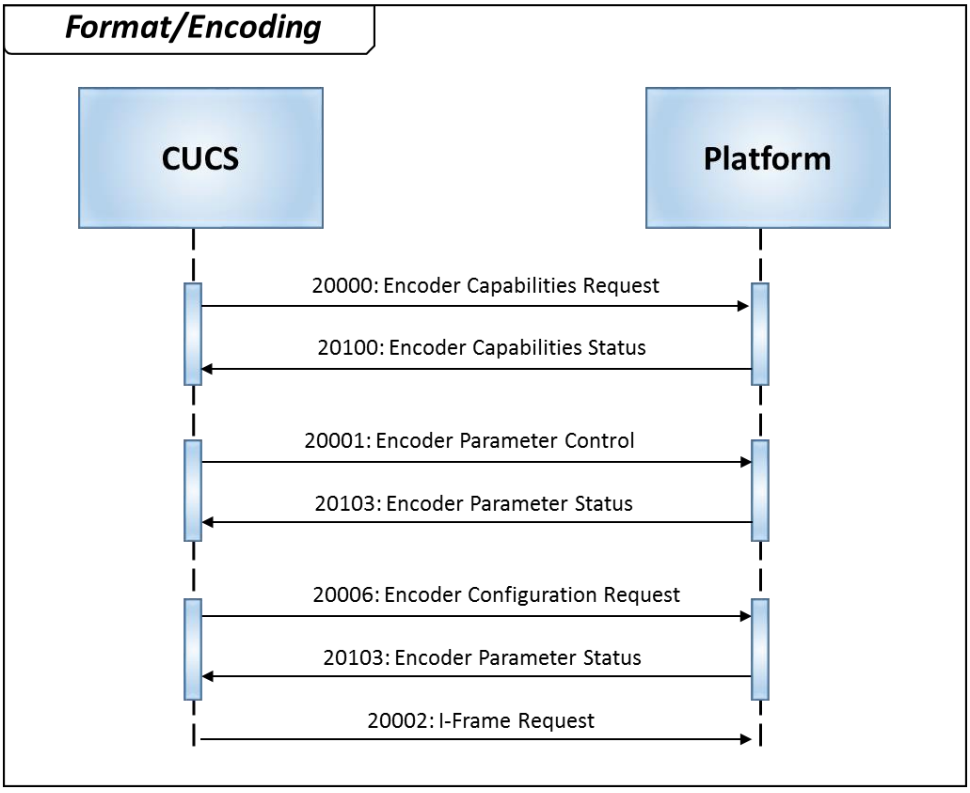

Figure 3: Motion Imagery Format and Encoding Properties

These six messages enable a platform to be backward compatible with prior generation CUCS', and vice versa, without resorting to a sub-optimal least common denominator approach that doesn't take full advantage of newer equipment.

10.1 Message #20000: Encoder Capabilities Request

Message #20000 *Encoder Capabilities Request* is sent by the CUCS to the platform to request the Motion Imagery encoder capabilities for a specific physical or virtual sensor (Station Number).

10.2 Message #20100: Encoder Capabilities Status

Message #20100 *Encoder Capabilities Status* is sent from the platform in response to a Message #20000 *Encoder Capabilities Request*. This message indicates the capabilities of the encoder that can be controlled by the CUCS using Message #20001 *Encoder Parameter Control*. This is a variable length message. The Presence of fields 10, 11, and 12 are dependent on the Available Encoding supported.

10.3 Message #20001: Encoder Parameter Control

Message #20001 *Encoder Parameter Control* is sent from the CUCS to the platform to set the operating parameters of the Motion Imagery encoder for a specific physical or virtual sensor. Note every field in Message #20001 does not necessarily have a corresponding field in Message #20100, such as those that vary per available encoding. This is a variable length message. The Presence of fields 13, 14, and 15 are dependent on the specified Encoding Format.

The Motion Imagery format defines the spatial pixel density (frame size) and temporal frame rate. A platform's default values are likely to match the Native format of the sensor for a High Definition or Enhanced Definition sensor, and constrained by the window format for a LVMI sensor.

Requirement(s)	
ST 1101-09	The Motion Imagery format shall be bounded by the maximum pixel density (frame size) and maximum temporal rate (frame rate) of the sensor.

Over-sampling the Native format of a sensor to deliver more spatial pixels or Frames per Second inflates the data to transmit and can reduce image quality. The CUCS may assume the encoder is capable of delivering frame sizes and rates less than specified in Message #20000. If the CUCS requests a reduced frame size or frame rate, the platform makes a best effort to honor the request. The platform's default image format is the format delivered in the absence of instruction to the contrary, i.e. Message #20001 not sent.

In the *Encoder Parameter Control* message, the **GOP Length** is the number of frames from one I-Frame to the next in an MPEG-compressed signal. **Intra-Refresh** is a H.264/AVC resiliency tool for encoding frames on a macro-block by macro-block basis, rather than as a complete frame; this effectively "spreads" an I-Frame over multiple frames. Intra-Refresh improves both the utilization of a fixed bandwidth data-link and error resiliency. Reference MISB RP 1011 [6] for more discussion of Intra-Refresh.

10.4 Message #20103: Encoder Parameter Status

Message #20103 *Encoder Parameter Status* is sent from the platform to the CUCS in response to Message #20001 *Encoder Parameter Control* to indicate the current value of the parameters the encoder is using. This is a variable length message. The Presence of fields 13, 14, and 15 are dependent on the specified Encoding format.

Requirement(s)	
ST 1101-10	A platform that conforms to MISB ST 1101 shall implement Message #20000 *Encoder Capabilities Request*, Message #20100 *Encoder Capabilities Status,* Message #20001 *Encoder Parameter Control, and Message* #20103 Encoder *Parameter Status.*

10.5 Message #20006: Encoder Configuration Request

Message #20006 *Encoder Configuration Request* informs the encoder the CUCS is requesting a predefined encoder configuration be used. This message allows predefined, pre-stored configurations to be loaded on command. This is especially useful when capability fields are not supported in Message #20001 *Encoder Parameter Control* to invoke the desired operation.

Requirement(s)	
ST 1101-11	An encoder shall respond to Message #20006 *Encoder Configuration Reques*t with Message #20105 *Encoder Configuration Response* indicating the current configuration.

It is recommended that any platform or CUCS that supports Motion Imagery support Message #20006.

Setting the Reset Device field to a value other than zero will cause the device to perform the specified reset operation. Setting the Configuration Number field to a value other than zero will cause the device to load the specified stored configuration. Setting both Reset Device and Configuration Number to zero will allow the software version of the device to be queried without performing any other operation.

The CUCS may send 4586 Message #1200 *Field Configuration Request* to discover the available predefined configurations; values for Fields 6, 7 and 8 are shown in Table 1. The CUCS uses this message to update DLI (Data Link Interface) parameter configuration data at the CUCS, and to potentially control the display of information.

Requirement(s)	
ST 1101-12	When a CUCS sends Message #1200 *Field Configuration Request,* the VSM shall respond with one or more Message #1302 *Field Configuration Enumerated Response* message(s) with configurations supported by the VSM.
ST 1101-13	A CUCS shall populate Message #1200 *Field Configuration Request* as indicated in MISB ST 1101 Table 1.

Table 1: 4586 Message #1200 Field Configuration Request Values

Unique ID	Field	Data Element Name & Description	Type	Value	Note
1200.06	6	Request Type	Unsigned 1	0	0 = Single Parameter
1200.07	7	Request Message	Unsigned 4	20006	The final message number for Load Predefined Configuration Request
1200.08	8	Request Field	Unsigned 1	6	The field number for the Configuration Number

The VSM responds with a Message #1302 *Field Configuration Enumerated Response* for each pre-defined configuration available.

10.6 Message #20105: Encoder Configuration Response

Message #20105 *Encoder Configuration Response* informs the client the encoder has performed the requested operation. In addition, this message returns the software version of the device.

It is recommended that any platform or CUCS that supports motion imagery support Message #20105.

10.7 Message #20002: I-Frame Request

Message #20002 *I-Frame Request* Message informs the encoder that the CUCS has suffered data loss and is requesting an I-Frame be sent to resynchronize. Message #20002 has no parameters other than those present in all payload messages. The encoder may honor Message #20002 at its own discretion. For example, if Intra-Refresh mode is enabled, the encoder might respond to Message #20002 by increasing the number of I-macro-blocks sent per frame over some period of time rather than sending an actual I-Frame.

It is recommended that any platform or CUCS that supports Motion Imagery support Message #20002.

11 Metadata Selection and Filtering

The MISP defines Metadata to support various capabilities. Some Metadata consumes significant bandwidth. This additional data needs to be accounted in determining the overall data rate versus transmission channel capacity. Reference MISB ST 0902 [4] for minimum metadata requirements.

Three messages support Motion Imagery Metadata (see Figure 4). The CUCS first sends Message #20003 *Meta-Data Catalog Request* and, in turn, receives a Message #20101 *Meta-Data Catalog* response. The CUCS selects a subset of Metadata from the returned catalog and replies with Message #20004 *Meta-Data Selection*. For the remaining session, the Motion Imagery (or Metadata only) stream contains just those requested elements – unless changed. A

CUCS has wide discretion as to which fields to request. No restrictions are imposed by these message definitions; actual implementations determine what makes sense for them.

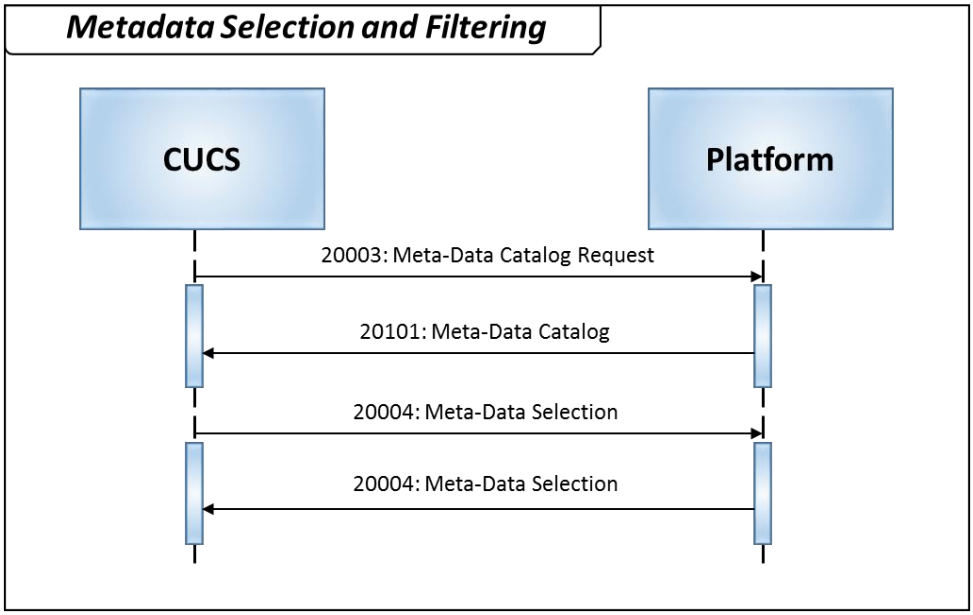

Figure 4: Messages for Metadata

Requirement(s)	
ST 1101-14	When Message #20003 *Meta-Data Catalog Request*, Message #20101 *Meta-Data Catalog,* and Message #20004 *Meta-Data Selection* are not used, a platform shall default, as a minimum, to sending the Minimum Metadata Set as defined in MISB ST 0902 [4].
ST 1101-15	A platform that implements MISB ST 1101 and is capable of delivering Metadata beyond that specified in MISB ST 0902[4] shall implement Message #20003 *Meta-Data Catalog Request*, Message #20004 *Meta-Data Selection*, and Message #20101 *Meta-Data Catalog* in accordance with PM ICD [2].
ST 1101-16	A Meta-Data Catalog shall consist of all KLV (Key-Length-Value) fields supported by the platform.
ST 1101-17	A CUCS that detects a missing packet in the Meta-Data Catalog shall re-request the catalog.
ST 1101-18	Each KLV key shall describe one Metadata element only (no groups are allowed).

Note the list of keys (KLV Key<n>) (see Table 14) is a variable length binary list of KLV keys in their universal ID 16-byte form. Because the size of the catalog may exceed the maximum allowable size for a 4586 message payload, provision is made for splitting the catalog data within the *Meta-Data Catalog* (Message #20101) and *Meta-Data Selection* (Message #20004) messages. Each of these two messages contains **Message Index** and **Message Total** fields. **Message Index** indicates the index of the current Metadata element in the catalog and **Message Total** indicates how many Metadata elements to expect. This is similar to the commonly used notation for numbering pages in a document, "2 of 6", "5 of 6", etc., where the first number is

the current page and the second is the total number of pages**. Key Count** is constrained to 30 for Message #20101 and 24 for Message #20004 to ensure the message payload size limit is not exceeded.

11.1 Message #20004: Meta-Data Selection

Message #20004 *Meta-Data Selection* includes a transmit rate **Key Rate** (in seconds) for each key. In other words, the Metadata element indicated by the key is sent by the platform to the CUCS at a specified rate. The rate specification allows a CUCS to request a lower than actual rate for reducing the bandwidth. A transmit rate of Key Rate =0.0 turns off the transmission of a key.

Requirement(s)	
ST 1101-19	A platform that detects a missing field in a requested Meta-Data Selection shall ignore the selection request, and send Message #20004 *Meta-Data Selection* back to the CUCS with Field 7 Key Count = 0 to signal a problem.
ST 1101-20	When a CUCS receives a Message #20004 *Meta-Data Selection* that indicates Field 7 Key Count = 0, it shall respond by resending the selection.
ST 1101-21	When a platform is unable to provide the metadata element at the rate the CUCS requests, the platform shall respond with Message #20004 *Meta-Data Selection* containing the actual rate it can support.
ST 1101-22	A platform shall not interpolate metadata to achieve a higher rate than the actual Metadata rate, which is to be treated as the upper bound for rate.

12 Appendix A – PM ICD Messages (Informative)

The normative specification for the following messages is [2].

12.1 Message #20005: Virtual Sensor Request Command

Table 2: Virtual Sensor Request Command (Message #20005)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20005.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20005.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20005.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20005.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.

12.2 Message #20102: Virtual Sensor Status

Note that v3.0.2 of PM ICD inadvertently omitted field 20102.05. Table 3 is correct.

Table 3: Virtual Sensor Status (Message #20102)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20102.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20102.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20102.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20102.04	4	Physical Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20102.05	5	Virtual Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20102.06	6	Virtual Station Status	Unsigned 1	Enumeration	0 = No sensor association 1 = Available virtual sensor 2 = In use virtual sensor
20102.07	7	Length of URI	Unsigned 1	Bytes	5-255
20102.08	8	Virtual Station Stream URI	Character [Length of URI]	None	No Restrictions

12.3 Message #20007: Payload Playback Configuration Command

Table 4: Payload Playback Configuration Command (Message #20007)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20007.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20007.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20007.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20007.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20007.05	5	Playback Mode	Unsigned 1	Enumerated	0 = Live 1 = from archive 2 = calibration image 3-128 = Reserved 129-255 = payload specific
20007.06	6	Playback Rate	Float	Fraction	0.0 <= x
20007.07	7	Seek Location (absolute time)	Double	Seconds	See 4586 1.7.2

Playback Mode specifies whether the given Station Number delivers a stream from a live (0) sensor, or is derived from archived (1) data. There is also an option to provide a calibration image (2), which is highly recommended. Values 3-128 are reserved to support future capabilities.

Playback Rate specifies the playback speed of the archived data as a fraction of the real-time rate. For example, a Playback Rate = 1.0 designates real-time playback; 0.0 designates paused; 2.0 designates a 2x real-time fast forward; and 0.5 designates half speed slow-motion.

Seek Location indicates a point in time to begin play with the value 0.0 denoting no change to the playback location (only rate is being changed). This field is ignored for Playback Mode 0 = Live.

Panning and zooming within an image may be accomplished by setting the Playback Rate = 0.0 (paused) at any point in time, and utilizing Message #200 *Payload Steering Command*. While the returned data is a Motion Imagery stream, to the user the effect is roaming over a large image space.

12.4 Message #20104: Payload Playback Operating State

Table 5: Payload Playback Operating State (Message #20104)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20104.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20104.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20104.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20104.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20104.05	5	Playback Mode	Unsigned 1	Enumerated	0 = Live 1 = from archive 3 = calibration image 3-128 = Reserved 129-255 = payload specific
20104.06	6	Playback Rate	Float	Fraction	0.0 <= x
20104.07	7	Seek Location (absolute time)	Double	Seconds	See 4586 1.7.2

12.5 Message #20000: Encoder Capabilities Request

Table 6: Encoder Capabilities Request (Message #20000)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20000.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20000.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20000.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20000.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.

12.6 Message #20100: Encoder Capabilities Status

Table 7: Encoder Capabilities Status (Message #20100)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20100.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20100.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20100.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20100.04	4	Station Number	Unsigned 4	Bitmapped	0x00000001 = Stn #1 0x00000002 = Stn #2 0x00000004 = Stn #3 0x00000008 = Stn #4 etc.
20100.27	5	Motion Imagery Control	Unsigned 4	Bitmapped	0x00000001 = Brightness Control Supported 0x00000002 = Color Control Supported 0x00000004 = Contrast Control Supported 0x00000008 = Tint Control Supported 0x00000010 - 0x00008000 = Reserved 0x00010000 - 0x80000000 = Encoder-Specific
20100.28	6	Motion Imagery Formats	Unsigned 2	Bitmapped	0x00000001 = 160x120 0x00000002 = 320x180 0x00000004 = 320x240 0x00000008 = 480x270 0x00000010 = 640x360 0x00000020 = 960x540 0x00000040 = 640x480 0x00000080 = 1280x720 0x00000100 = 1920x1080 0x00000200 = 3840x2160 0x00000400 = 7680x4320 0x00000800 - 0x00800000 = Reserved 0x01000000 - 0x80000000 = Encoder-Specific
20100.25	7	Bit Depth	Unsigned 1	Bitmapped	0x01 = 8-bits 0x02 = 10-bits 0x04 = 12-bits 0x08 = 14-bits 0x10 - 0x80 = Encoder-Specific
20100.29	8	Frame Rate Decimation	Unsigned 1	Bitmapped	0x01 = Frame Rate Decimation Supported

Unique ID	Field	Data Element Name & Description	Type	Units	Range
					0x02 - 0x80 = Encoder-Specific
20100.08	9	Available Encodings	Unsigned 4	Bitmapped	0x00000001 = Meta-Data Only 0x00000002 = MPEG-1 0x00000004 = MPEG-2 0x00000008 = H.261 0x00000010 = MPEG-4 Part 2 ASP 0x00000020 = Motion JPEG 0x00000040 = H.264/MPEG-4 Part 10 0x00000080 = H.265/HEVC 0x00000100 - 0x00008000 = Reserved 0x00010000 - 0x80000000 = Vehicle-Specific
If H.264 conditional begins ("Available Encodings" bit 6 == 1)					
20100.22	10	H.264 Profile[1]	Unsigned 1	Bitmapped	0x01 = Constrained Baseline 0x02 = Main 0x04 = High 0x08 - 0x80 = Encoder-Specific
If H.264 conditional ends					
If H.265 conditional begins ("Available Encodings" bit 7 == 1)					
20100.36	11	H.265 Profile	Unsigned 1	Bitmapped	0x01 = Main 0x02 = Main 10 0x04 - 0x80 = Encoder-Specific
If H.265 conditional ends					
If MPEG-2 conditional begins ("Available Encodings" bit 2 == 1)					
20100.23	12	MPEG-2 Profile/Level	Unsigned 1	Bitmapped	0x01 = MP@ML 0x02 = MP@HL 0x04 - 0x80 = Encoder-Specific
If MPEG-2 conditional ends					
20100.31	13	Maximum GOP Length	Unsigned 2	Frames	1 ≤ x
20100.32	14	Maximum B Frames	Unsigned 1	Frames	X ≤ 4
20100.22	15	Infinite GOP / Intra-Refresh	Unsigned 1	Bitmapped	0x01 = Infinite GOP Supported 0x02 = Intra-Refresh Supported

[1] H.264/AVC Level is determined by the Motion Imagery format selected. See MISP [3].

Unique ID	Field	Data Element Name & Description	Type	Units	Range
					0x04 - 0x80 = Encoder-Specific
20100.24	16	Maximum Effective Intra-Refresh GOP Length	Unsigned 2	Frames	1 ≤ x
20100.18	17	Transport	Unsigned 1	Bitmapped	0x01 = MPEG-2 TS over Raw UDP/IP 0x02 = MPEG-2 TS over RTP/UDP/IP 0x04 = ES over RTP/UDP/IP 0x08 - 0x80 = Encoder-Specific
20100.19	18	Max Bit Rate	Unsigned 4	bps	No restrictions
20100.35	19	Predefined Encoder Configurations	Unsigned 1	None	X = 0 (Predefined Configurations not supported) 1 ≤ x (Number of available Predefined Configurations)

12.7 Message #20001: Encoder Parameter Control

Table 8: Encoder Parameter Control (Message #20001)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20001.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20001.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20001.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20001.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20001.05	5	Brightness	Unsigned 1	None	0x00 = minimum brightness 0xFF = maximum brightness
20001.06	6	Color	Unsigned 1	None	0x00 = minimum saturation 0xFF = maximum saturation
20001.07	7	Contrast	Unsigned 1	None	0x00 = minimum contrast 0xFF = maximum contrast
20001.08	8	Tint	Unsigned 1	None	0x00 = maximize green 0x80 = normal color 0xFF = maximum magenta

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20001.23	9	Motion Imagery Formats	Unsigned 1	Enumerated	0 = 160x120 1 = 320x180 2 = 320x240 3 = 480x270 4 = 640x360 5 = 960x540 6 = 640x480 7 = 1280x720 8 = 1920x1080 9= 3840x2160 10= 7680x4320 11-23 = Reserved 24-31 = Encoder Specific 32-255 = Do Not Use
20001.21	10	Bit Depth	Unsigned 1	Enumerated	0 = 8-bits 1 = 10-bits 2 = 12-bits 3 = 14-bits 4-7 = Encoder Specific 8-255 = Do Not Use
20001.24	11	Frame Rate Decimation	Integer	None	0 ≤ x ≤ 59 where output frame rate = input frame rate/(x+1)
20001.12	12	Encoding Format	Unsigned 1	Enumerated	0 = Meta-Data only 1 = MPEG-1 2 = MPEG-2[2] 3 = H.261 4 = MPEG-4 Part 2 ASP 5 = Motion JPEG 6 = H.264/AVC[3] 7 = H.265/HEVC 8-15 = Reserved 16-31 = Payload Specific 32-255 = Do Not Use
If H.264 conditional begins ("Encoding Format" == 6)					
20001.18	13	H.264 Profile[3]	Unsigned 1	Enumerated	0 = Constrained Baseline 1 = Main 2 = High 3-7 = Encoder Specific 8-255 = Do Not Use
If H.264 conditional ends					
If H.265 conditional begins ("Encoding Format" == 7)					
20100.25	14	H.265 Profile	Unsigned 1	Enumerated	0 = Main

[2] Approved MISB compression formats; other formats are non-interoperable within the community.

[3] H.264/AVC Level is determined by the Motion Imagery format selected. See MISP [3].

Unique ID	Field	Data Element Name & Description	Type	Units	Range
					1 = Main 10 2-7 = Encoder Specific 8-255 = Do Not Use
If H.265 conditional ends					
If MPEG-2 conditional begins ("Encoding Format" == 2)					
20001.19	15	MPEG-2 Profile/Level	Unsigned 1	Enumerated	0 = MP@ML 1 = MP@HL 2-7 = Encoder-Specific 8-255 = Do Not Use
If MPEG-2 conditional ends					
20001.16	17	GOP Length 1 = I-Frame only > 1 = IP (set Field 18 B Frames = 0) or IBP	Unsigned 2	Frames	0 = Infinite GOP 1 = I-Frame only 2 to Maximum GOP Length = IP or IBP GOP
20001.17	18	B Frames	Unsigned 1	Enumerated	0 to Maximum B-Frames
20001.26	19	Effective Intra-Refresh GOP Length	Unsigned 2	Frames	0 = Intra-Refresh Disabled 1 to Maximum Effective Intra-Refresh GOP Length = Effective GOP length
20001.14	20	Transport	Unsigned 1	Enumerated	0 = MPEG-2 TS over Raw UDP 1 = MPEG-2 TS over RTP/UDP 2 = ES over RTP/UDP 3-7 = Encoder Specific 8-255 = Do Not Use
20001.15	21	Bit Rate	Unsigned 4	bps	No restrictions

12.8 Message #20103: Encoder Parameter Status

Table 9: Encoder Parameter Status (Message #20103)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20103.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20103.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20103.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20103.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20103.09	5	Brightness	Unsigned 1	None	0x00 = minimum brightness 0xFF = maximum brightness

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20103.10	6	Color	Unsigned 1	None	0x00 = minimum saturation 0xFF = maximum saturation
20103.11	7	Contrast	Unsigned 1	None	0x00 = minimum contrast 0xFF = maximum contrast
20103.12	8	Tint	Unsigned 1	None	0x00 = maximize green 0x80 = normal color 0xFF = maximum magenta
20103.05	9	Motion Imagery Formats	Unsigned 1	Enumerated	0 = 160x120 1 = 320x180 2 = 320x240 3 = 480x270 4 = 640x360 5 = 960x540 6 = 640x480 7 = 1280x720 8 = 1920x1080 9= 3840x2160 10= 7680x4320 11-23 = Reserved 24-31 = Encoder Specific 32-255 = Do Not Use
20103.25	10	Bit Depth	Unsigned 1	Enumerated	0 = 8-bits 1 = 10-bits 2 = 12-bits 3 = 14-bits 4-7 = Encoder Specific 8-255 = Do Not Use
20103.06	11	Frame Rate Decimation	Integer	None	$0 \leq x \leq 59$ where output frame rate = input frame rate/(x+1)
20103.17	12	Encoding Format	Unsigned 1	Enumerated	0 = Meta-Data only 1 = MPEG-1 2 = MPEG-2[4] 3 = H.261 4 = MPEG-4 Part 2 ASP 5 = Motion JPEG 6 = H.264/AVC[5] 7 = H.265/HEVC 8-15 = Reserved 16-31 = Payload-Specific 32-255 = Do Not Use
If H.264 conditional begins ("Encoding Format" == 6)					

[4] Approved MISB compression formats; other formats are non-interoperable within the community.

[5] H.264/AVC Level is determined by the Motion Imagery format selected. See MISP [3].

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20103.23	13	H.264 Profile[5]	Unsigned 1	Enumerated	0 = Constrained Baseline 1 = Main 2 = High 3-7 = Encoder-Specific 8-255 = Do Not Use
If H.264 conditional ends **If H.265** conditional begins ("Encoding Format" == 7)					
20103.07	14	H.265 Profile	Unsigned 1	Enumerated	0 = Main 1 = Main 10 2-7 = Encoder Specific 8-255 = Do Not Use
If H.265 conditional ends					
If MPEG-2 conditional begins ("Encoding Format" == 2)					
20103.24	15	MPEG-2 Profile/Level	Unsigned 1	Enumerated	0 = MP@ML 1 = MP@HL 2-7 = Encoder Specific 8-255 = Do Not Use
If MPEG-2 conditional ends					
20103.24	16	GOP Length 1 = I-Frame only > 1 = IP or IBP	Unsigned 2	Frames	0 = Infinite GOP 1 = I-Frame only 2 to Maximum GOP Length = IP or IBP GOP
20103.25	17	B Frames	Unsigned 1	Enumerated	0 to Maximum B-Frames
20103.08	18	Effective Intra-Refresh GOP Length	Unsigned 2	Frames	0 = Intra-Refresh Disabled 1 to Maximum Effective Intra-Refresh GOP Length = Effective GOP length
20103.20	19	Transport	Unsigned 1	Enumerated	0 = MPEG-2 TS over Raw UDP/IP 1 = MPEG-2 TS over RTP/UDP/IP 2 = ES over RTP/UDP 3-7 = Encoder Specific 8-255 = Do Not Use
20103.09	20	Bit Rate	Unsigned 4	bps	No restrictions

12.9 Message #20006: Encoder Configuration Request

Table 10: Encoder Configuration Request (Message #20006)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20006.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20006.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20006.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5

20006.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20006.05	5	Reset Device	Unsigned 1	Enumerated	0 = None 1 = Reset 2-255 = VSM-specific
20006.06	6	Configuration Number	Unsigned 1	Enumerated	0 - None 1-15 = Reserved 16-255 = VSM-specific

12.10 Message #20105: Encoder Configuration Response

Table 11: Encoder Configuration Response (Message #20105)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20105.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20105.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20105.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20105.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20105.05	5	Reset Device	Unsigned 1	Enumerated	0 = None 1 = Reset Initiated 2 - 255 = Vehicle Specific Reset Initiated
20105.06	6	Configuration Number	Unsigned 1	Enumerated	0 = None 1-15 = Reserved 16-255 = VSM-specific configuration loaded
20105.07	7	Software Version	Character 20	ASCII	Device dependent version information

12.11 Message #20002: I-Frame Request

Table 12: I-Frame Request (Message #20002)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20002.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20002.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20002.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5

20002.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.

12.12 Message #20003: Meta-Data Catalog Request

Table 13: Meta-Data Catalog Request (Message #20003)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20003.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20003.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20003.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20003.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.

12.13 Message #20101: Meta-Data Catalog

Table 14: Meta-Data Catalog (Message #20101)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20101.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20101.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20101.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20101.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20101.05	5	Message Index	Unsigned 2	Number	1 <= X <= Message Total
20101.06	6	Message Total	Unsigned 2	Number	No restrictions
20101.07	7	Key Count	Unsigned 1	Number	0 <= X <= 30
Keys repetition begins (where n = 1 to 30)					
20101.08	8	KLV Key<n>	Binary 16	KLV Key, 16 bytes	Valid MISP KLV keys

12.14 Message #20004: Meta-Data Selection

Table 15: Meta-Data Selection (Message #20004)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
20004.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
20004.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
20004.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
20004.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
20004.05	5	Message Index	Unsigned 2	Number	1 <= X <= Message Total
20004.06	6	Message Total	Unsigned 2	Number	No restrictions
20004.07	7	Key Count	Unsigned 1	Number	0 <= X <= 24
Key/Rate repetition begins (where n = 1 to 24)					
20004.08	See Note [6]	KLV Key<n>	Binary 16	KLV Key, 16 bytes	Valid MISP KLV key
20004.09	See Note [7]	Key Rate (0.0 = stop sending)	Float	Seconds	>= 0.0

[6] Field is a loop for n keys beginning with Field 08.

[7] Field is a loop for n keys beginning with Field 09.

13 Appendix B – Proposed Messages (Informative)

The messages described here have not yet been accepted into the PM ICD. They are for future consideration only.

13.1 Image Coordinate System

LVMI sensors raise the question of image coordinate system. While the imagery delivered from traditional High and Enhanced Definition sensors is generally assumed to be in raw camera/pixel space, with LVMI sensors it is common to deliver the imagery in a geographic coordinate system. For this reason, Message #M1 *Set Coordinate System* is added (Table 16). This message is a setup message analogous to Message #201, and impacts the meaning of Message #200. Beyond the standard fields that all messages have, Message #M1 has a single enumerated field with four coordinate systems currently as defined in Table 17.

Table 16: Set Coordinate System (Message #M1)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
0XYZ.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
0XYZ.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
0XYZ.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
0XYZ.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
0XYZ.05	5	Coordinate System	Unsigned 1	Enumerated	See Table 17

Table 17: Image Coordinate System Enumeration

Mode	Image Coordinate System	Interpretation of Message #200
0	Default Camera / Pixel Space	Unchanged
1	Geo-registered north-is-up	0200.07 – 0200.10 change units to Meters or Meters/sec rather than Radians or Radians/ sec
2	Geo-registered up-is-up	0200.07 – 0200.10 change units to Meters or Meters /sec rather than Radians or Radians/sec
3	Relative Camera Space up-is-up	0200.07 – 0200.10 change units to fraction of FOV (0.0 to 1.0) or fraction of FOV/sec rather than Radians or Radians /sec

Message #M2 *Image Coordinate System Status* retrieves the current coordinate system in use on the platform.

Table 18: Image Coordinate System Status (Message #M2)

Unique ID	Field	Data Element Name & Description	Type	Units	Range
0XYZ.01	1	Time Stamp	Double	Seconds	See 4586 1.7.2
0XYZ.02	2	Vehicle ID	Integer 4	None	See 4586 1.7.5
0XYZ.03	3	CUCS ID	Integer 4	None	See 4586 1.7.5
0XYZ.04	4	Station Number	Unsigned 4	Bitmapped	0x0001 = Stn #1 0x0002 = Stn #2 0x0004 = Stn #3 0x0008 = Stn #4 etc.
0XYZ.05	5	Coordinate System	Unsigned 1	Enumerated	See Table 17

STANAG 4586 by default assumes a physical gimbal capable of panning and tilting by various angles. LVMI steerable MI windows typically assume a coordinate system of the earth's surface with an ability to slide a region-of-interest about that surface with an assumed nadir view. It is therefore desirable to add the two geo-registered coordinate systems mentioned above (Mode 1 and 2 in Table 17. The units of measurement describing the FOV (field of view) extent and the slew rate become Meters and Meters per Second in these two systems, respectively. Specification of a Stare Point remains a Latitude-Longitude coordinate.

The last coordinate system (Mode 3 in Table 17) – camera space up-is-up – is a slight modification of the default 4586 space. Like the default 4586 space, this space is a camera space that provides a more convenient unit for specification of field-of-view extent and slew rate. Since the size and location of the steerable region-of-interest (ROI) are constrained by the full FOV of the physical sensor as a whole, it is convenient to specify quantities relative to the full FOV. This space has defined its units for FOV extent as a fraction of full FOV. For example, a value of 0.1 for 0200.07 (horizontal FOV) indicates an ROI 1/10 the width of the full size FOV. A value of 1.0 indicates a ROI covering the entire full FOV. The slew rate follows a similar convention. See Example 1 in Appendix C for a use of coordinate system Mode 3.

[Potential future requirement if proposed message adopted: Systems shall always support (and default to) Mode=0 for full compatibility with existing CUCS. Some re-projection of the imagery may be required to produce the expected Motion Imagery output stream.]

14 Appendix C – Virtual Station Usage Examples (Informative)

14.1 Example 1: HD physical sensor with child ED virtual sensor

The STANAG 4586 commands in this document provide a means to format High Definition (HD) content for an Enhanced Definition (ED) display device. While the *Encoder Parameter Control* permits setting the width and height of an image from a sensor, it doesn't specify what combination of scaling and cropping is needed to support a desired image size. However, the combination of the messages described in this section and those in Section 7, provide this flexibility when used with a virtual sensor.

An ED CUCS initially discovers and takes control of the desired physical sensor. Upon discovering the sensor is natively a HD format, via the *Encoder Capabilities* messages of Section 10, the CUCS locates the physical sensor's virtual sensor with Messages #20005 and #20102. The CUCS obtains control of the virtual sensor and place it into coordinate system Mode 3 (relative to physical full FOV) using the Message #M1 *Coordinate System Message* of Section 13.1. The CUCS sends Messages #201 and #200 to the virtual sensor to position and size the FOV within the physical full FOV. Once this configuration is complete, the CUCS displays the MI stream using the virtual sensor and pan, tilt, and otherwise control the physical sensor as desired.

Alternatively, the default coordinate system (Mode 0) may be used. In this case, whenever the FOV of the physical sensor changes, that of the virtual sensor needs to be updated by the CUCS to match. This is because the FOV in the default coordinate system is an absolute angle rather than relative to the parent physical FOV.

Use of the virtual sensor may be skipped if the CUCS prefers the native HD FOV, or if the default scale/crop HD-to-ED conversion behavior of the sensor is acceptable. Two logical choices for scale/crop are to chip out (crop) an ED image from the higher pixel density HD image, or scale the HD content to fit the ED format. In the first, a chip out may improve image quality, because the bits allocated to code the imagery are spent on less image content. In the second, the HD content is downscaled to fit the ED format; typically the vertical dimension is preserved while the left and right image edges are cropped. Again, since less image content is coded (with respect to the HD source) the imagery may be improved for the given bandwidth. More detail on optimal scaling and cropping is found in MISB RP 0904 [7].

14.2 Example 2: One LVMI sensor with many ED/HD virtual sensors

Virtual sensors are ideal in supporting multiple windows or soda-straw views delivered by a LVMI sensor. The LVMI sensor as a whole is the physical sensor and each window is an independent virtual sensor.

A CUCS begins by querying the physical sensor for a virtual sensor, rather than by obtaining control of the physical sensor, as done in Example 1. Control of the physical sensor is not required to perform the query, since the query does not change the state of the physical sensor in any way. Control of the physical sensor is likely to be reserved for the platform operator, not individual users. Discovery of a virtual sensor via Messages #20005 and #20102 is recommended even if the platform only has a single physical sensor. This is because Message

#20005 will attempt to return an unused virtual sensor, which saves the CUCS from iterating through the virtual sensors until it locates one not in use.

Once a virtual sensor is discovered, control is assumed and a suitable coordinate system selected, such as Mode 2 or 3 (see Table 17). From this point, the CUCS may pan, tilt, and otherwise steer/control the virtual sensor with Messages #201 and #200. The CUCS displays the MI stream from the virtual sensor. No attempt is made to control the physical sensor, unlike in Example 1.